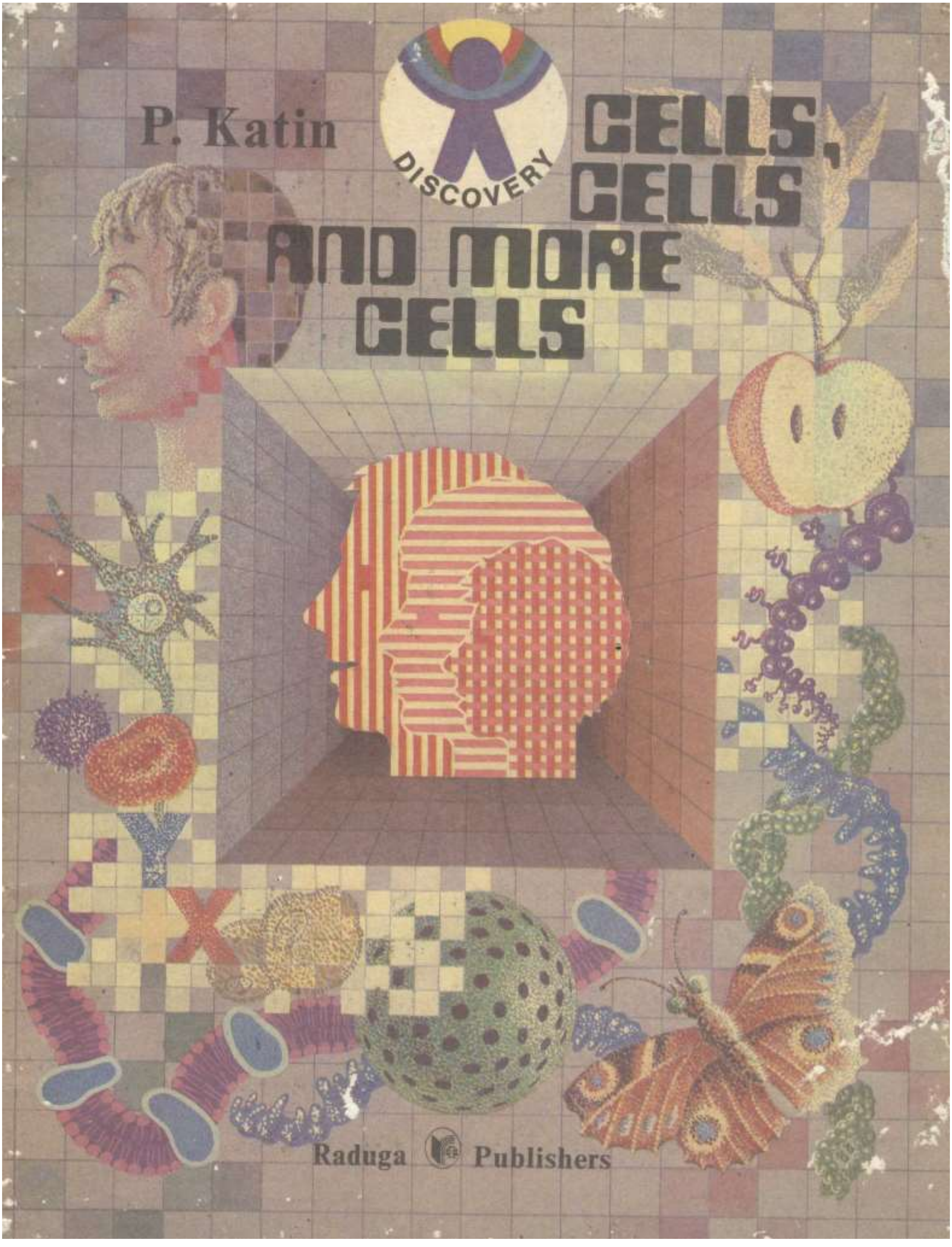
P. Katin

DISCOVERY

CELLS, CELLS AND MORE CELLS



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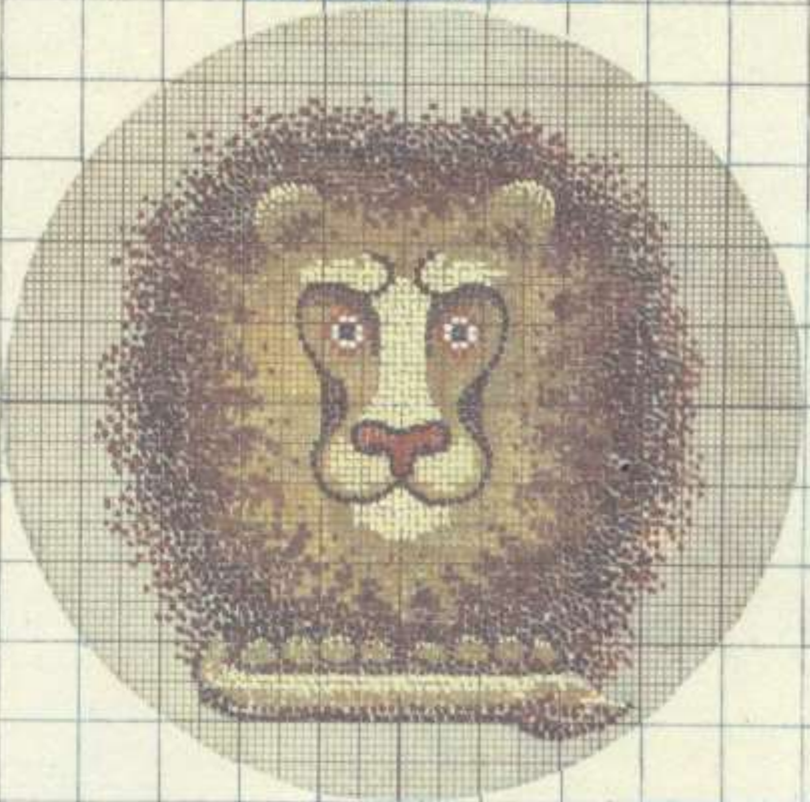

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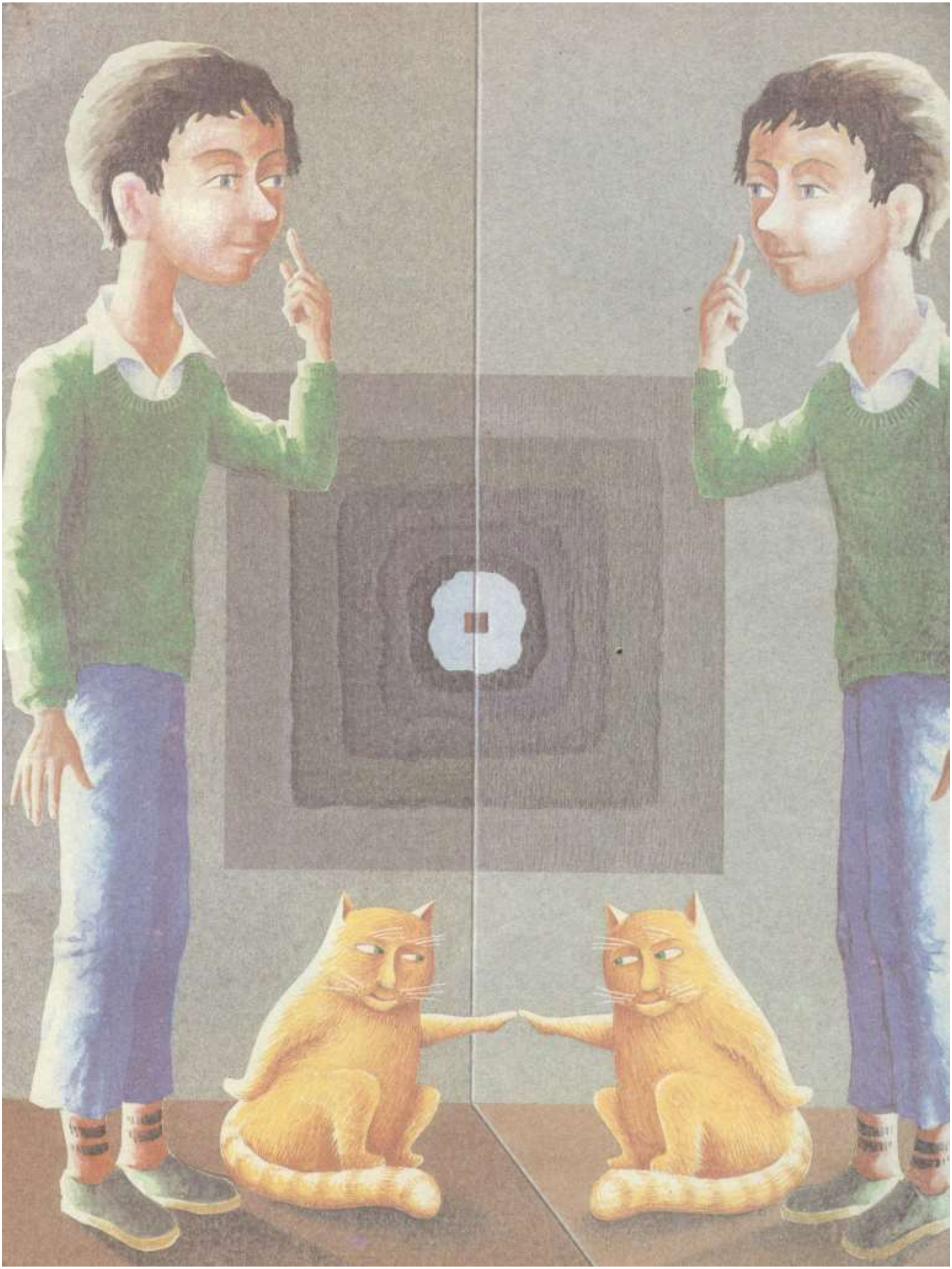


I

HOW DID YOU BEGIN?

Do you have a mirror at home? Go and take a good look at yourself. There is your nose, your ears, your eyes and your mouth. If the mirror is large or if you have already crawled up on a chair, then you can see your shoulders, your arms and your stomach. Where did all those different parts of you come from? They simply grew. Remember, you were smaller on your last birthday than you are now. And your arms were smaller, and your legs, and your ears, and even your nose. And two years ago on your birthday you were even smaller. You probably don't remember what you looked like three years ago. But believe me (and if you don't, ask your mother, or father or grandmother) before that you were very small.

And before that? Before that you were very tiny, **smaller than the smallest dot on a piece of paper.** And you can't give that dot legs or arms or a nose. Not because the pencil is too thick, but because you did not have them then. And you didn't have ears, or eyes, or a stomach.

You were a cell. One tiny, little cell.

If you want to know what a cell is and where it came from, read further.

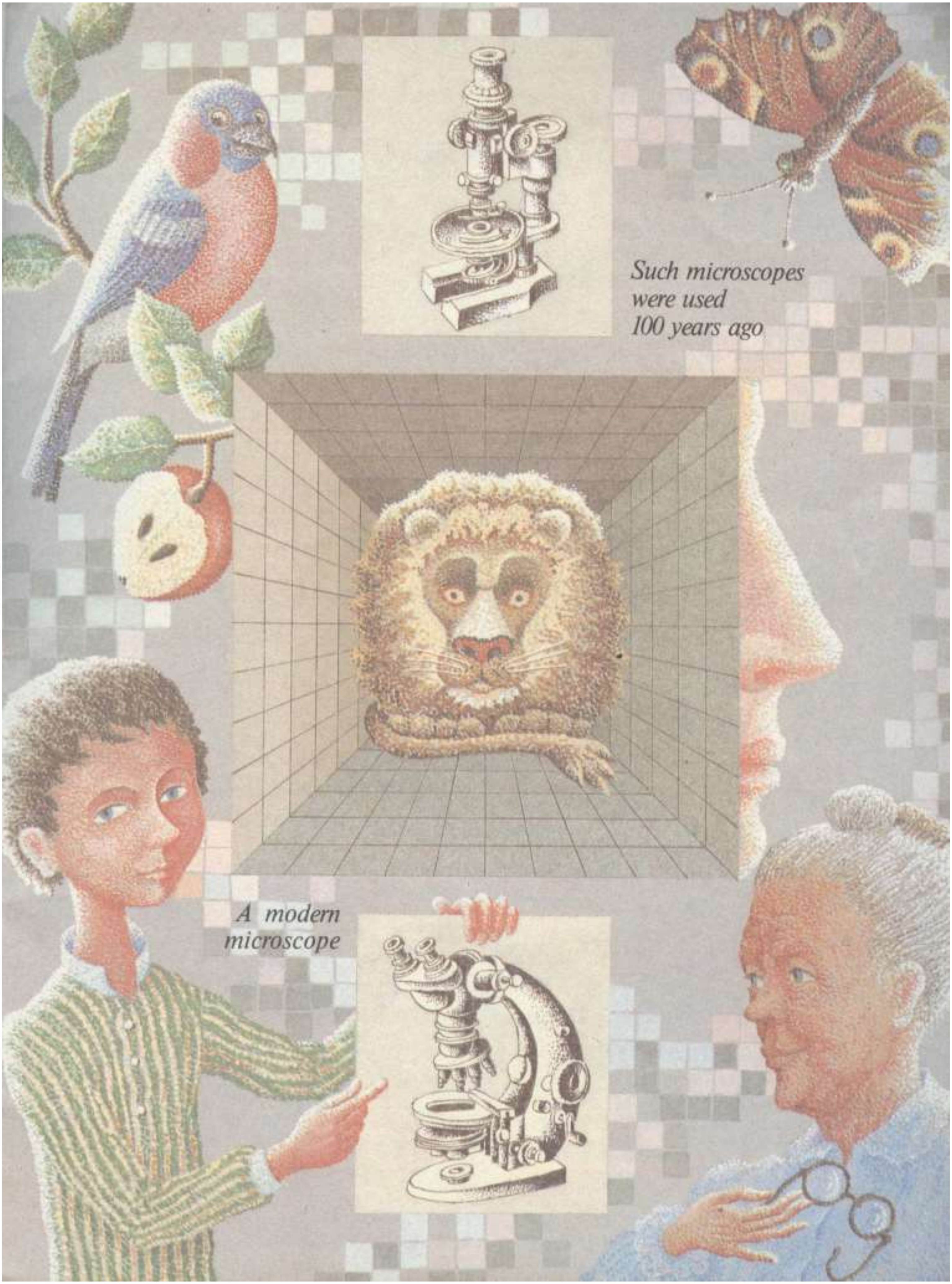
II
CELLS

Let's go to the zoo. First we will visit the lion. There he is. Let's go closer. Even closer. Don't be afraid, he is in a cage! There. Now we can see his nose. Let's take a magnifying glass and look through it. What do we see? Smooth, damp skin and that is all.

But what if we had many magnifying glasses and we laid one on top of the other? Then we would have an instrument called a microscope. It magnifies everything around you. There are microscopes which can magnify one hundred and even one thousand times. So, if we had a microscope, then we would see that the skin on the lion's nose is made of separate little parts, and these parts are called cells.

Not only the lion's nose is made of cells, but his tongue and tail, and insides too. Almost everything in the lion's body. And the lion is not the only animal with cells. Elephants, and giraffes, and bears have them too. Actually, every living thing is made almost entirely of cells. Even grass. Even trees. Even your grandmother. And even (but this is just between us) your father's nose. I wonder how many cells his nose has?

You are also made of these cells. **And you started out as just one.** But we will talk about that a little later.

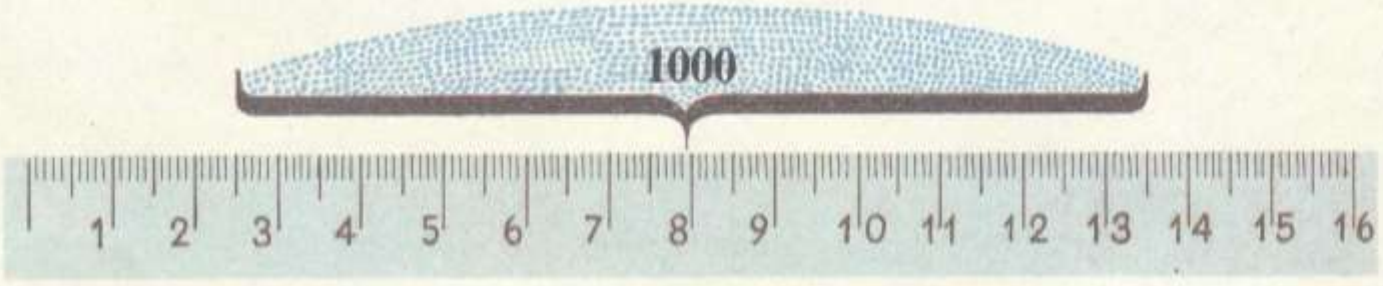


Such microscopes were used 100 years ago

A modern microscope

HOW BIG ARE CELLS?

Very, very small. So small that you can only see them with a microscope. A cell is a million times smaller than you are. If we could take cells and put them in a line on your ruler, there would be about a thousand of them between the smallest divisions on the ruler which is one millimeter. The cell is to a grain of sand, what the grain of sand is to a wheel on a car. Even a tiny dot on a piece of paper is a lot bigger than the ordinary cell. See how small cells are?



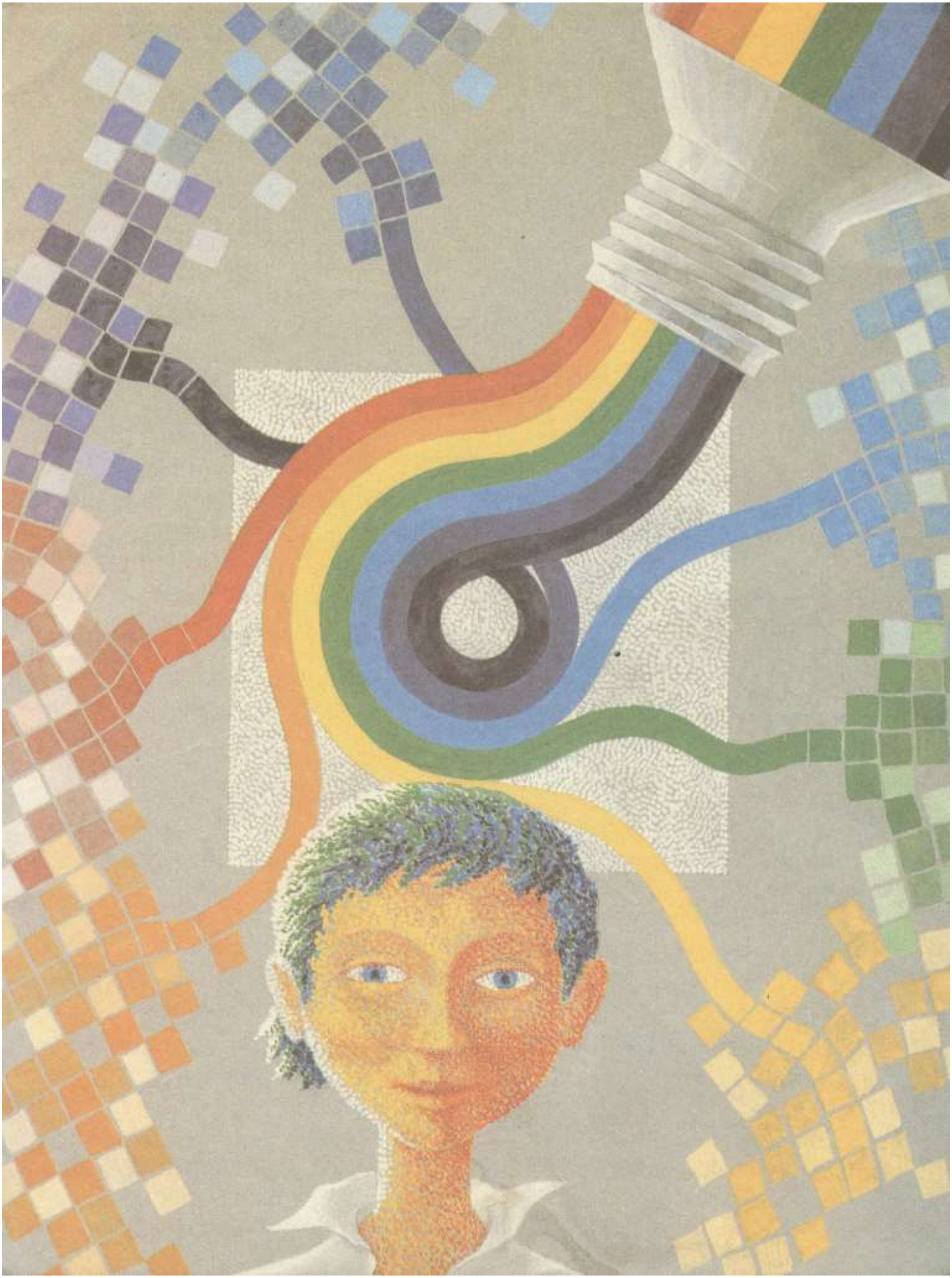
IV

WHAT COLOR ARE CELLS?

When you go to bed tonight, look at yourself carefully. You will probably find at least a few dark spots, or birthmarks, on your skin. They are dark because the cells in them are full of black or dark brown matter.

And you have red cells. They float in your blood. In each drop of blood there are several million of these cells. If you would take them out of that drop (as is done when analysing your blood), then the red color would leave the blood along with those cells. **Blood is red because it contains red cells.**

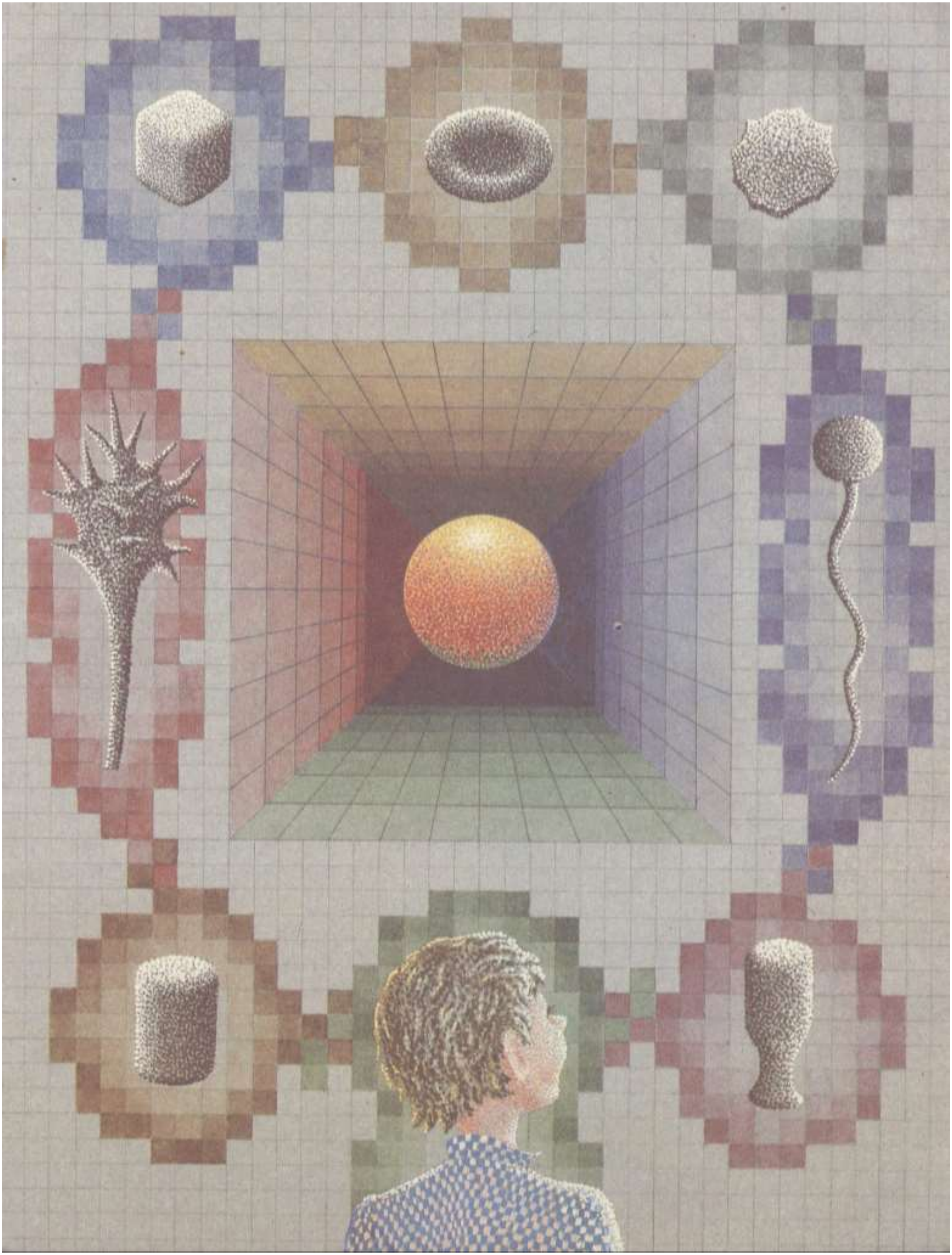
But most cells are colorless and transparent. That is why cells are colored with a special dye so we can see them under the microscope. Then they become blue, red, green and even luminous if they are dipped in special luminous dye.



WHAT SHAPES ARE CELLS?

Different shapes. There are round cells which float in the blood. And nearby there are cells which look like saucers. They are the cells which are red and give blood its color. And there are flat cells like fish scales. Skin is made of these. And there are cells which resemble a cup. And some which look like a block. There are even goblet-shaped cells. But that is not all! Many cells have little hairs sticking out in different directions. They are even smaller than cells, and you know how small cells are! There are also cells with one long tail much longer than the cell itself. These cells look like tiny snakes.

So what shapes are cells? The best answer is probably: **all shapes.**



VI

WHAT ARE CELLS MADE OF?

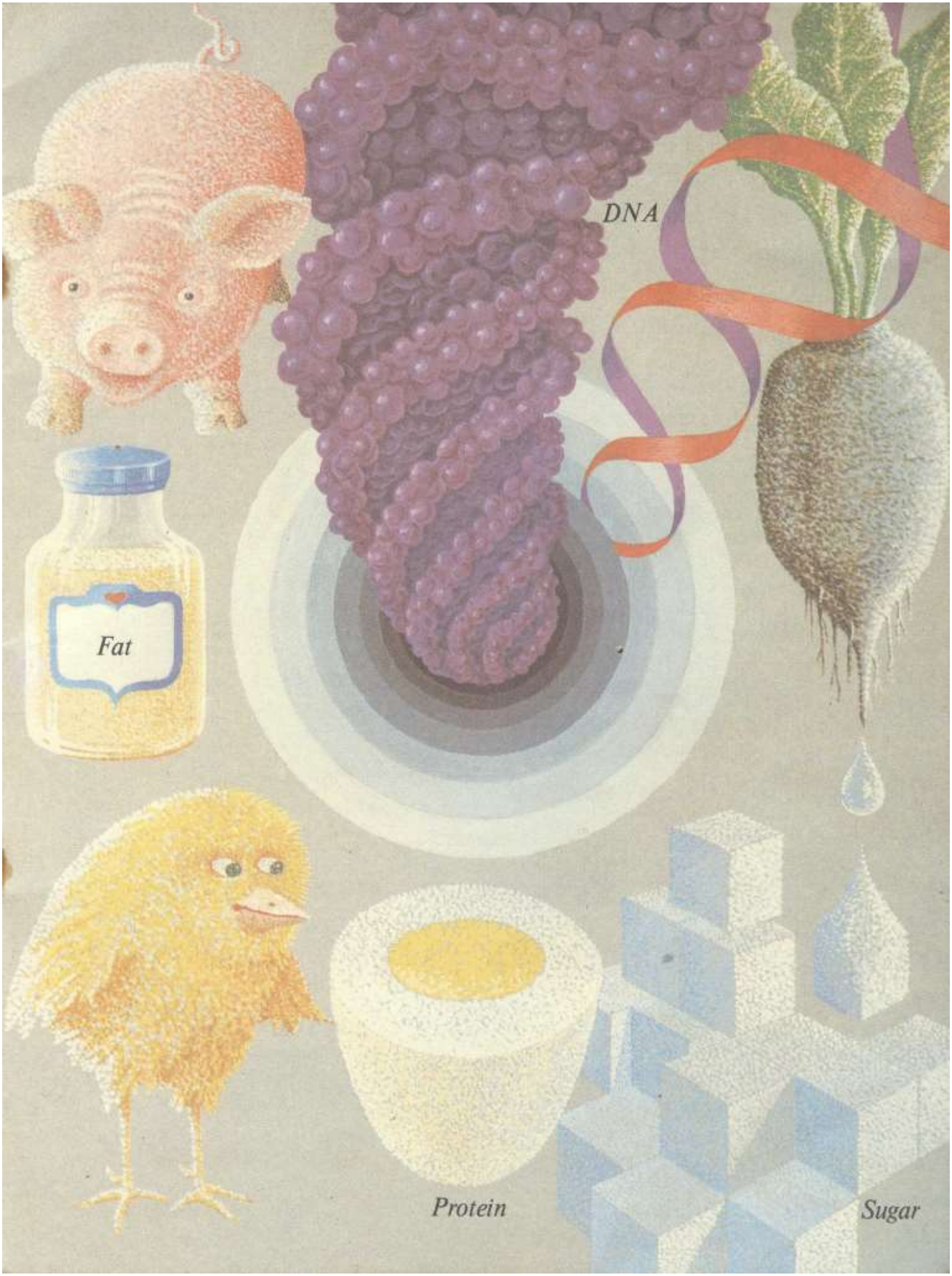
Basically cells are made of **protein.** And they have **fat**, like in soup broth. It even floats in the cell like fat in a soup bowl you let sit for too long. The outside of cells also have a layer of fat.

Besides protein and fat, there is also **sugar**. In some cells there is more, in others less. Beets have so much that they are even called sugar beets. Sugar which you sprinkle on your cereal is made from the cells of these beets.

Cells contain other substances but there is so little of them that we will not talk about them. Except for one.

A person needs all the parts of his body: his arms, and legs, and stomach. But the most important part is his head and the brain inside it. You see, it directs the arms, and legs, and even the stomach. Your brain remembers what happened yesterday and thinks about what to do tomorrow. Well, there is something a little like that in the cell. This substance looks like thin threads. Thin and long. And the name of it is long. It is probably the longest and most complicated word you have ever heard. It is **de-oxy-ribo-nu-cleic acid.**

There is not much of it in your cells. Much less than protein, fat and sugar. But it is the most important substance in your cells, and we will talk about it later. And so we don't have to write (here we go!) deoxyribonucleic acid every time, we will shorten it. We will take the first letter D, and the letter N from the middle, and then the letter A instead of the word acid. So from that long word we have only three letters **DNA.** That is what everyone calls this substance. But don't forget that this is only a shortened form of the real name: deoxyribonucleic acid.



DNA
Fat
Protein
Sugar

VII

HOW ARE CELLS MADE?

Cells are very, very complicated. So complicated that no one knows everything about how they are made. Scientists are still trying to find out more. For this there are complicated instruments and huge microscopes. They are so big that special buildings have to be constructed for them. It is funny that in order to see a cell hundreds of times smaller than a grain of sand we need a microscope as big as a house! But with these microscopes scientists have been able to learn something about how a cell is made.

Let us begin with the outside. All cells are surrounded by a thin covering made of protein and fat. This covering is called a **membrane** or a plasma membrane to be more exact. It is so thin that you can barely see it even with the most powerful microscope. If you look very carefully, you will notice that the line is actually two. The membrane is made of two layers — the outer and the inner.

Though it is very difficult to get a good look at the cell membrane, it is still very important. I will tell you why.

Your mother and father feed you. Sometimes they give you a delicious pie and at other times not so delicious cereal. But you need to eat both because they are good for you. They would not give you food that was bad for you.

This is what a cell or plasma membrane looks like

STOP
An electron microscope
The object to be observed is in here
Here's where you look

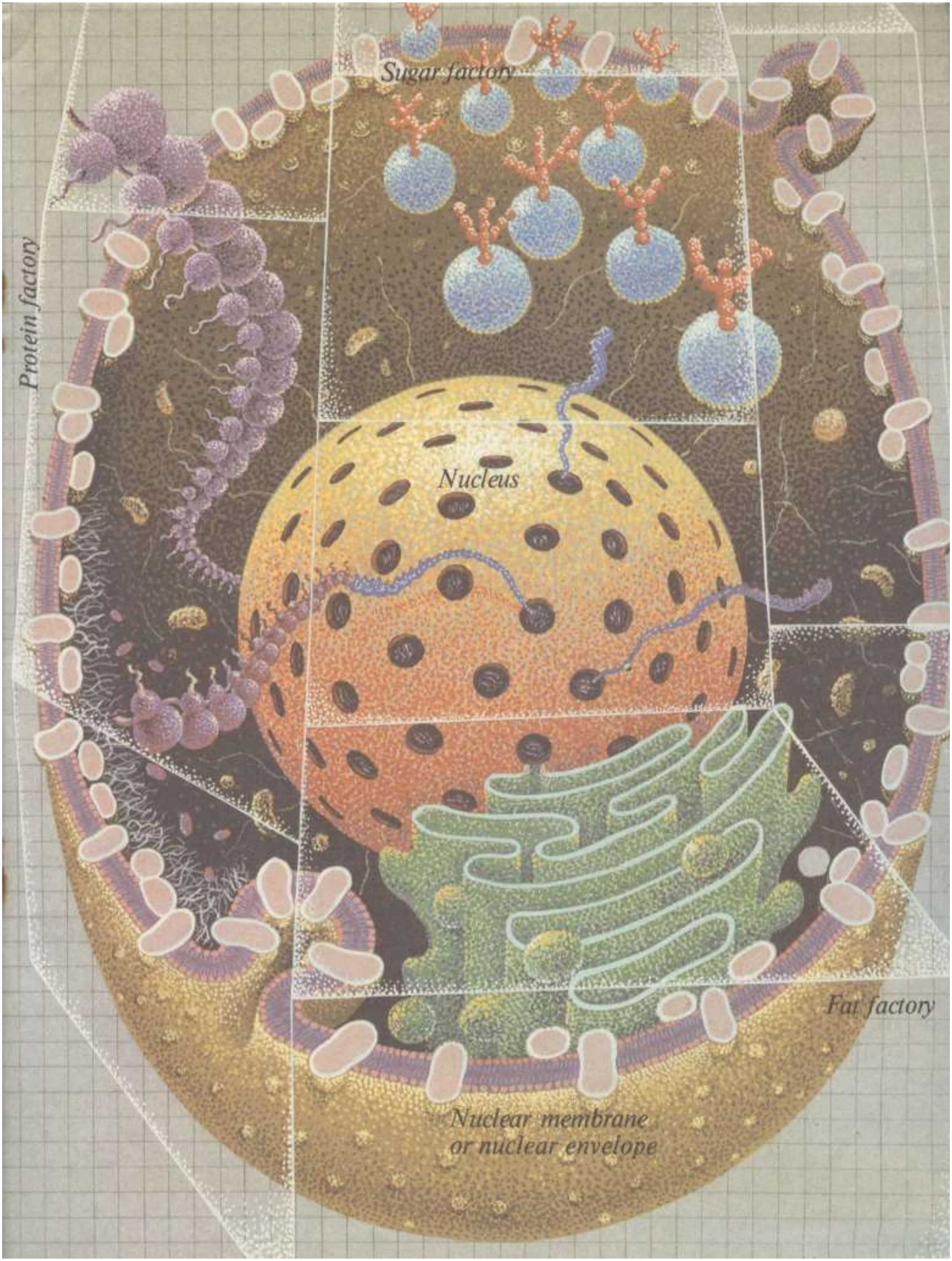
Cells have to decide for themselves what is good for them and what is harmful. Many different substances float around them. But what is amazing is that only good things get into the cell. It is the membrane which sees to this. It allows useful substances to pass freely but it does not let harmful substances in. **This means it can distinguish one substance from another.** So far, we know very little of how it does this.

But that is not all the cell membrane can do!

When cells touch one another, their membranes stick together. If they did not do this we would fall apart into millions of separate cells. But a cell only sticks to a cell which is the same kind and does not stick to a cell which is different. **This means the membrane can distinguish one cell from another.**

So, the outside of a cell is its membrane. And what is inside? Everything that is inside the membrane is called **cytoplasm.** It is the major part of the cell. And there is a reason. Cytoplasm is like a large factory. The protein and sugar and fat which cells are made of are all produced in the cytoplasm. Just like in a real factory, the finished products are sent to different places on order. Some remain in the cytoplasm, others are sent further, to the membrane, and still others are sent out of the cell (like, for example, the saliva in your mouth).

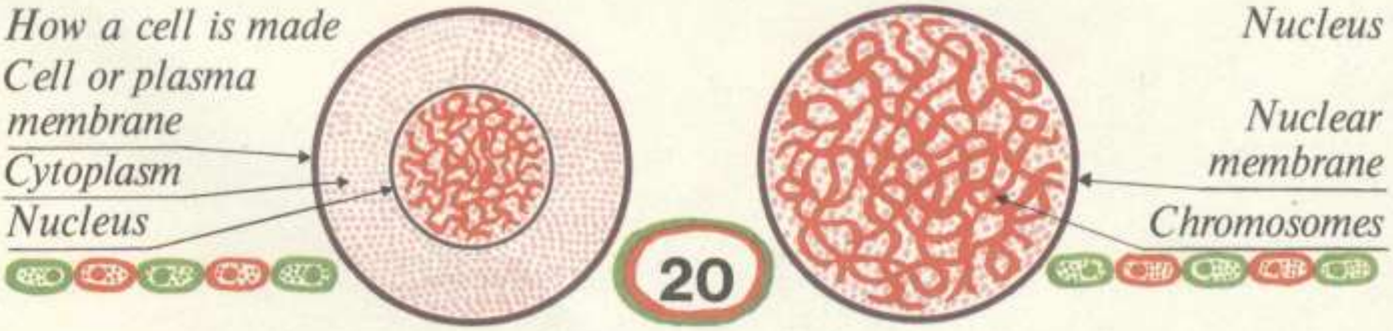
And the substances in a cell are not the only ones to move in different directions. The cell itself does.


Sugar factory
Protein factory
Nucleus
Fat factory
Nuclear membrane
or nuclear envelope

Do you remember when you cut your finger not long ago? Try to find the cut. There is almost no sign of it. Because cells moved towards the wound from all sides and filled it up. Your cut healed. But cells do not have arms and legs. In order to move they have to stretch one side and pull up the other, like a worm. For this the cell has muscles, like you and I do, only they are very thin. These are also located in the cytoplasm.

And finally we have come to the most important part. The **nucleus** is in the cytoplasm and it contains the thing the cells need most. You haven't forgotten already, have you? That's right, DNA. Something so important must be guarded. That is why the nucleus is surrounded by its own membrane, called a nuclear membrane, or a nuclear envelope. Just like the cell is. The nucleus is much smaller than the cell, so the long threads of DNA are wrapped in tight braids so they can all fit. These are called **chromosomes.**

Each of your cells has 46 of them. And each of mine does too. The cells of all normal people contain 46 chromosomes. Read the next chapter to find out why we need chromosomes.



Nuclear membrane
Nucleus

VIII

WHY DO WE NEED CHROMOSOMES?

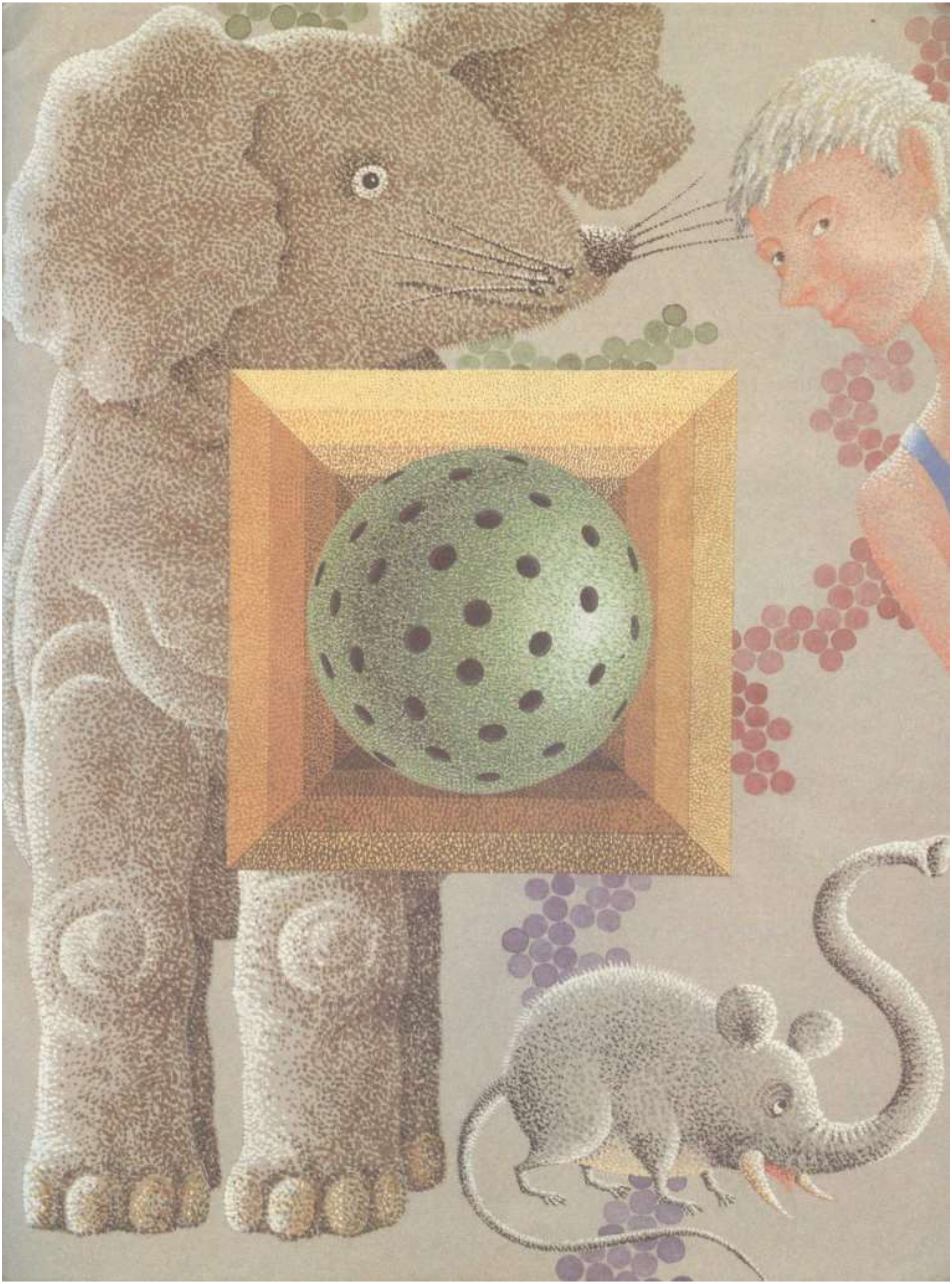
A mouse does not look like an elephant, and a beetle does not look like a cow. No one would mix you up with the boy next door, or confuse him with his brother if they are not twins.

Why is that? You might say that a mouse is small and an elephant is big and has a trunk. The boy next door is snub-nosed and has freckles and does not look anything like you.

And again I ask why? Why doesn't a mouse look like an elephant? Why does the boy next door have a snub nose and freckles, and you don't? Why don't people look like one another? And why don't animals?

This all depends on chromosomes. A mouse's chromosomes are not like those of an elephant, and yours are not like those of the boy next door. **Everything that makes one living creature different from another is contained in the chromosomes.** And how the cells come together to make a nose instead of a stomach. And what color someone's eyes should be. And the color of his hair. And the shape of his ears. And the length of his fingers. All of this information is contained in the chromosomes.

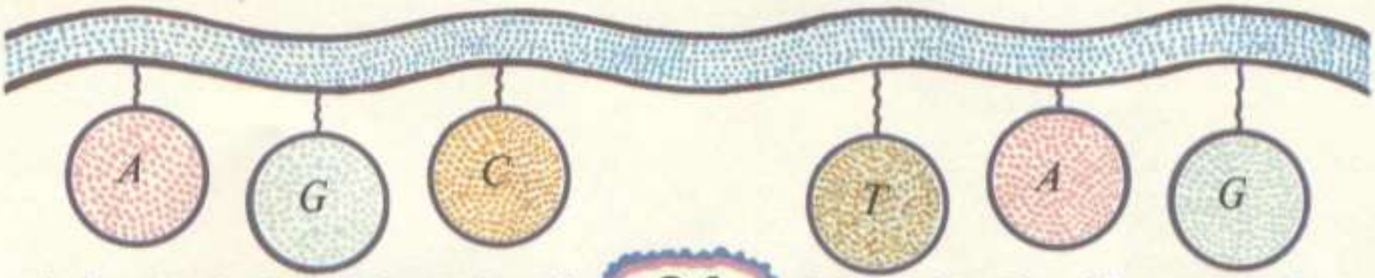
The language of chromosomes is not simple. And the recordings do not look anything like our writing. By the

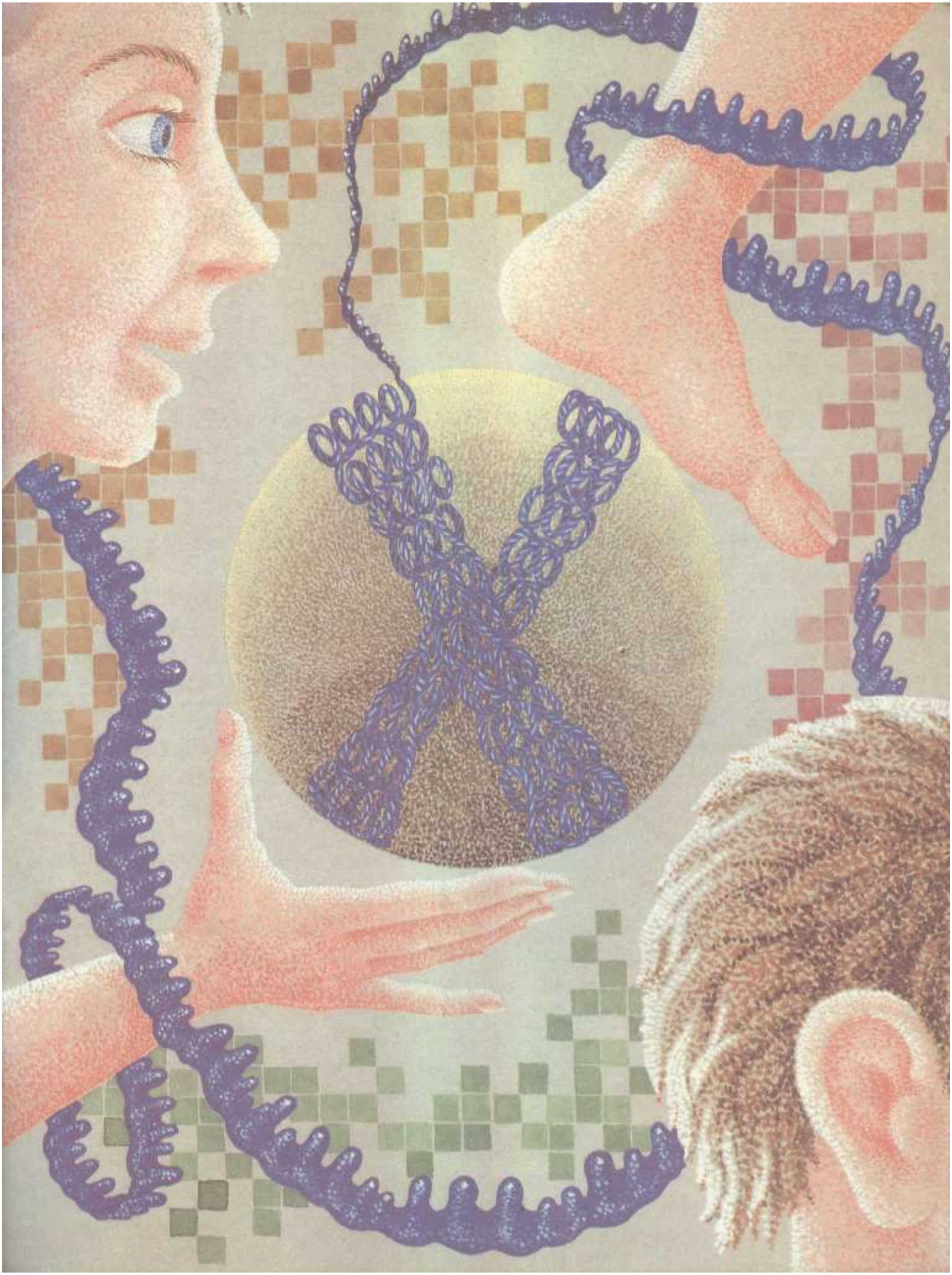


way, people did not always write with letters. The Chinese and Japanese still use special symbols instead of letters, called hieroglyphics. And several nationalities in ancient times used knots on a rope for recording information.

The chromosomes look like those knot recordings. But instead of knots, special substances are fastened to the threads of DNA. There are only four of them: adenine, guanine, cytosine and thymine. They are shortened to the first letters of each word: A, G, C, and T. They are like the letters of the cell alphabet. Words are made from these. Only in our language words are of different lengths. There are short ones like cat, and long ones like rhinoceros. But in the language of chromosomes all the words have only three letters. There is CAG, TAG, AGA, CCC, and more. Together they form long orders showing what, how and when the cell should do something.

The language of chromosomes is very precise and even in the longest recordings there are usually no mistakes.





IX

CHILDREN FROM CELLS

You already know that you grew from one single cell. But how did that happen? The cell is so tiny and look at how big and tall you have become!

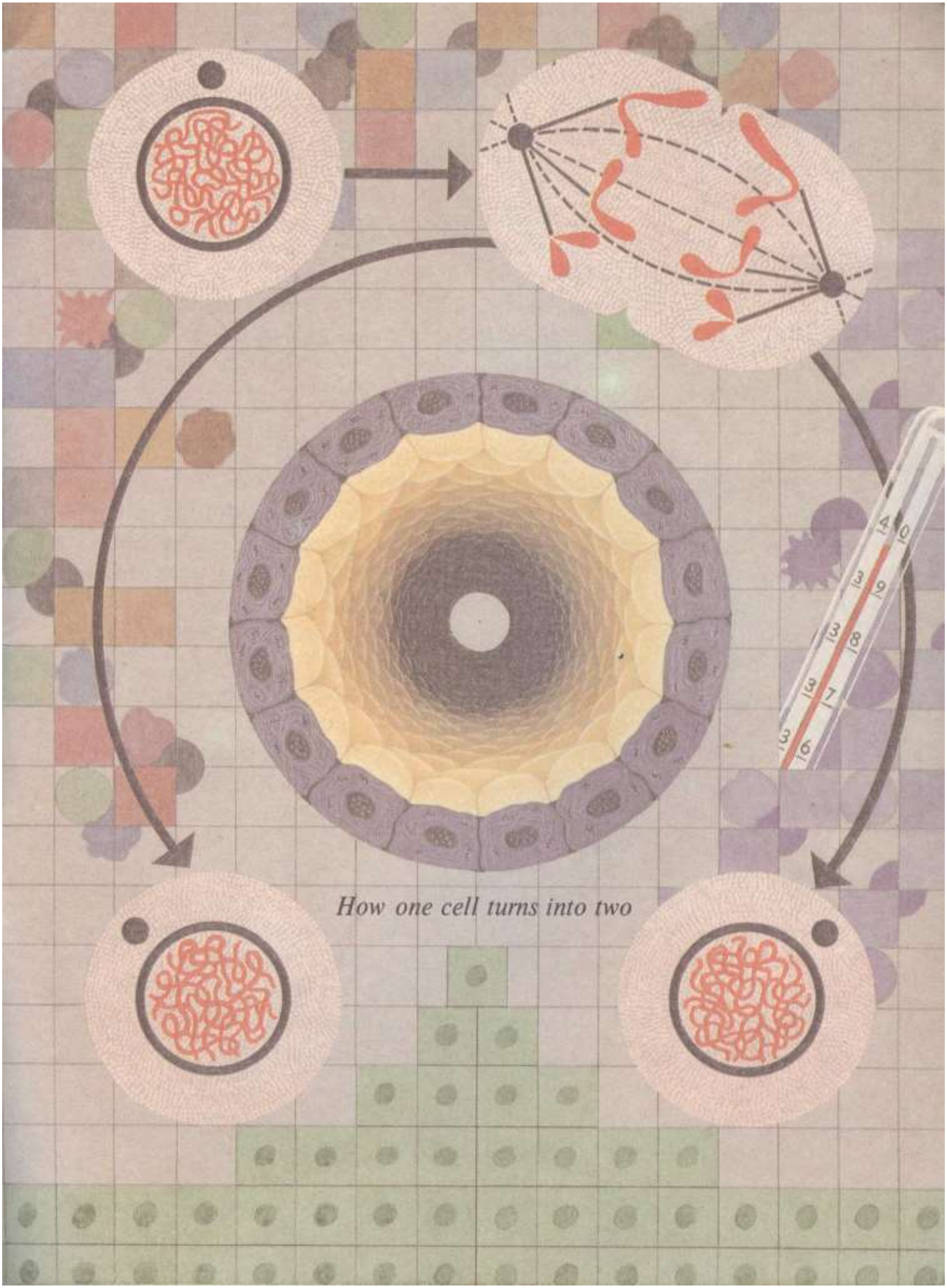
I will tell you how it happened. The cell began to divide. First into two, and then the two into four. Each of them divided in half again, and this went on and on. It is impossible to count how many cells are in your body now. Probably many millions.

And you are still growing. Every second the cells in your body continue to divide, and there are more and more of them. In your arms, and in your legs, and in your ears. And each of those cells has a membrane, citoplasm and a nucleus. And in the nucleus there are 46 chromosomes. **And the chromosomes in the new cells are exactly like those in the very first one.** This is because the cell makes another nucleus, membrane, cytoplasm and complete set of chromosomes before it divides. So when it does divide, everything is evenly split between the two cells.

This way, there are identical chromosomes in all the cells, and that means the orders which are written on them are also identical.

But there is a riddle. The orders are identical, but the cells are different. Some are round, others are oval, some are black, others are red. Maybe not everything is written in the chromosomes? Scientists think everything is. But some cells obey one order, while other cells obey another.

We still do not know everything about how they choose the necessary order. But we need to. Because various diseases start because the cells get mixed up and do not know which order to follow. Perhaps by the time you grow up, scientists will have learned to manage the disobedient cells and to save people from many illnesses. Maybe you will be the one to do that.



How one cell turns into two

X

HOW ARE CHILDREN MADE?

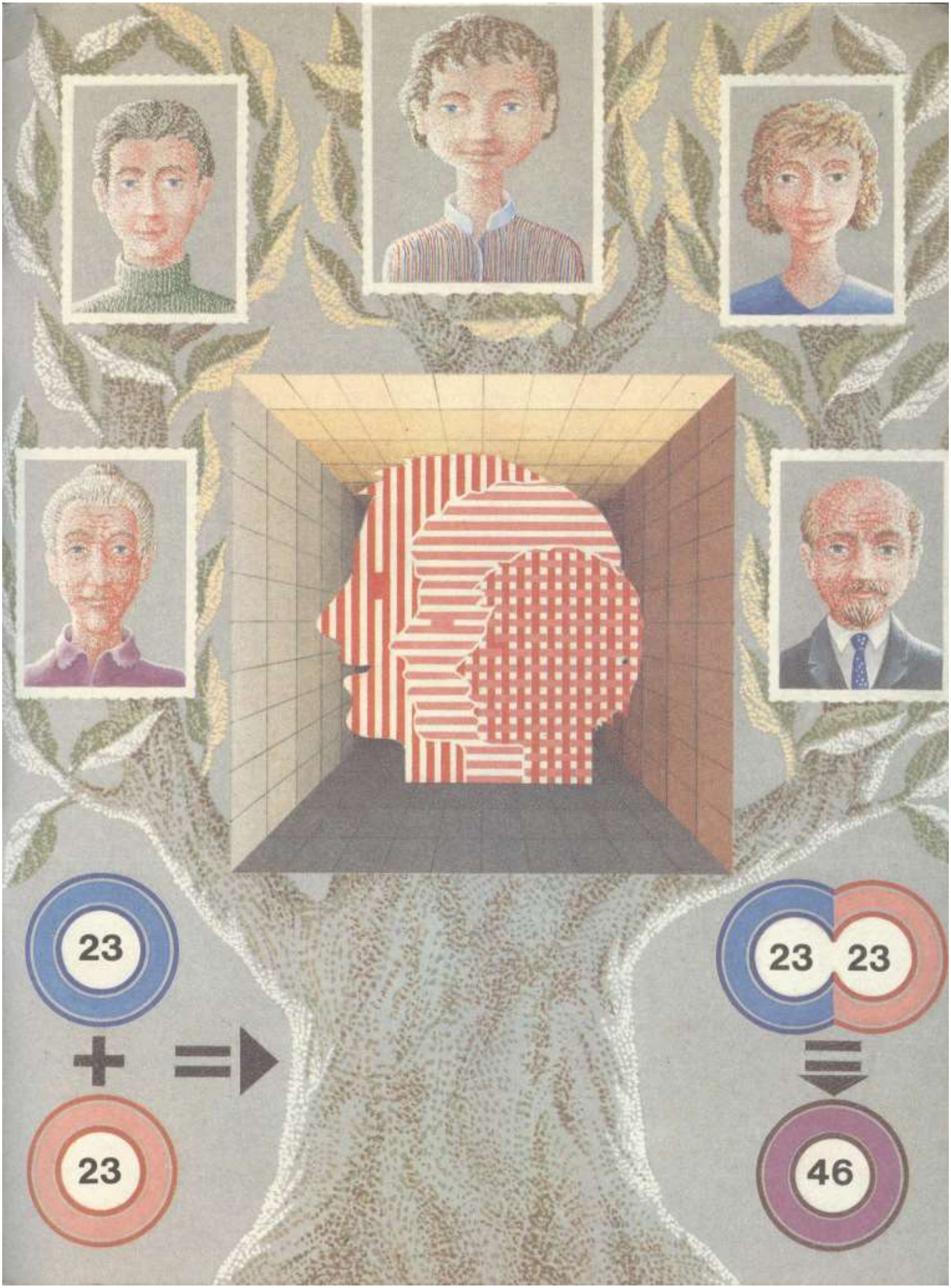
You can partly answer this question yourself. There was one single cell. It divided and divided, and there were more and more cells, until finally a child was made.

But where did the first cell come from, the one that began it all? It came from two — one from the mother and one from the father.

Among the millions of cells which your body is made of there are special cells. They can do things that other cells cannot. They can join and serve as the beginning of a new life. All animals and all humans have these cells. The joining of two of these cells, one from your father and one from your mother, created the one which you began from. **But before these cells joined into one, both of them had gotten rid of half of their chromosomes, otherwise...** Otherwise you would have twice as many as you need. You would have 92 instead of 46. And that should not happen.

Now you know that half the chromosomes in your cells came from your mother and half from your father. But your mother got half of her chromosomes from her mother, your grandmother, and half from her father, your grandfather. And the same is true of your father. So some of your chromosomes came from your grandmothers and your grandfathers. And one or two from your great-grandmother. So you still look a little like her. And maybe in many years, your great-grandson will look like you.

See how wonderfully everything is done!


23
23
23 23
46

XI
A BOY OR A GIRL?

Who will come from that cell, a boy or a girl? **This also depends on the chromosomes.**

When you look at chromosomes under the microscope, you can see that they are all different. Some are short while others are long. Some are shaped like sling-shots, and others are straight like sticks.

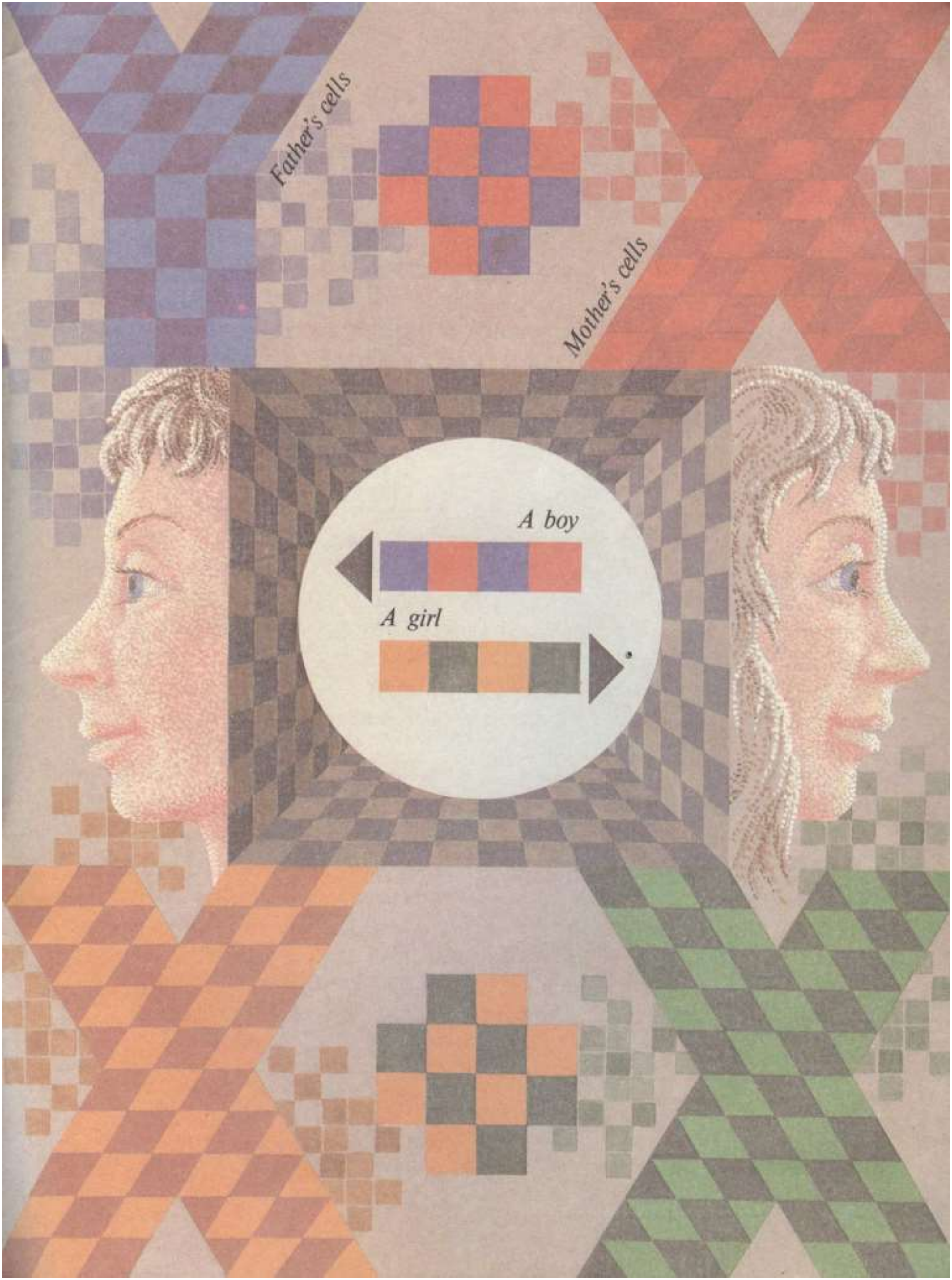
Scientists have not discovered which chromosomes determine the color of your eyes or the shape of your nose. But the chromosomes which determine whether a child will be a girl or a boy are known and even have their own names. They are called by letters of the alphabet. One is the letter X, and the other is the letter Y.

Like all other chromosomes, these two come to you from your parents. The X chromosome came from your mother. Later you will be able to say, which chromosome came from your father.

You see, both your mother's cells and your father's cells have the X chromosome. But the Y chromosome is only in your father's cells. **This chromosome contains the information which makes a boy different from a girl.**

You already know that before two cells join together, they get rid of half their chromosomes. In the mother's cell, only an X chromosome remains (because she does not have a Y chromosome). But in the father's cell there can be either an X or a Y chromosome. This is what decides who will be born after a mother's and father's cells join. If the father's X chromosome joins with the mother's, then the child will be a girl. But if the Y chromosome was in the father's cell, then a boy will be born.

Now you can say which chromosome you got from your father.

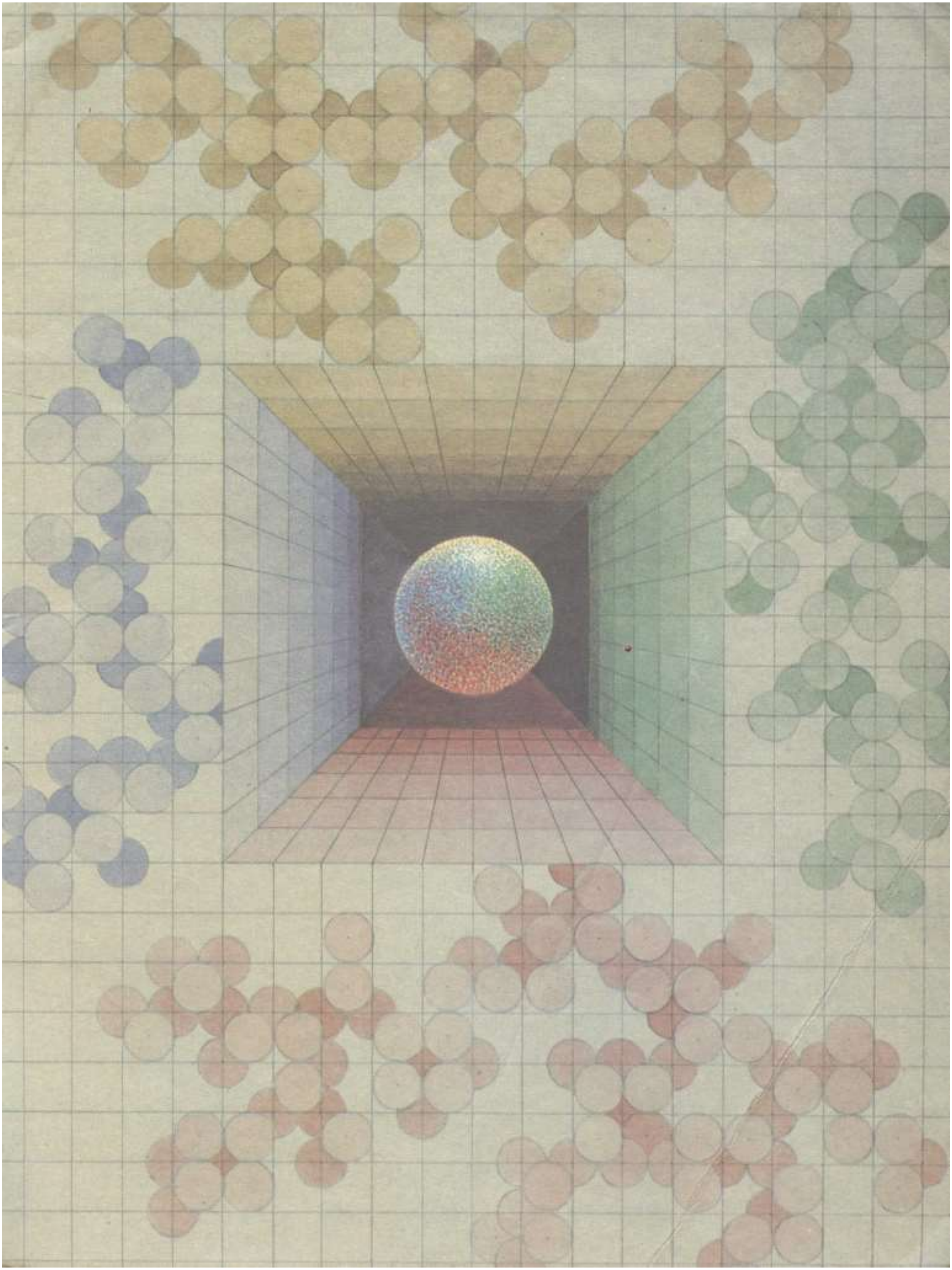

Father's cells
Mother's cells
A boy
A girl

NOW WHAT DO YOU KNOW?

A great deal! You know that every living thing is made of cells. You know that cells multiply by dividing in half. You know that you came from one single cell that appeared when a cell from your father joined with a cell from your mother. And you have also learned about how a cell is made: a membrane on the outside, cytoplasm inside, and a nucleus in the cytoplasm. In the nucleus are chromosomes containing all the information about what the cell should do.

See how many interesting things you can learn by asking just one simple question: "Where did I come from?" And think how many interesting things you still do not know. Why does a cell suddenly begin to divide? How does it fight against harmful germs? How does a cell move? How do new animals appear if children always resemble their parents? Why are plants green and we aren't? Why is a frog cold, while we have a temperature of 36.6 degrees Celsius if we do not have a fever? And why do we get fevers?

Some of these questions do not have answers yet. We still have much to learn. And to do that we must study. If you understood what was written in this book, then you can say that your studies have begun. Even if you do not remember everything, that is no problem. Read this book again after a while. And maybe you will find other books about the tiny cells which make up grass, and trees, and your grandmother, and you yourself, and even (but this is just between us) your father's nose.



In 1989 Raduga Publishers are launching a new DISCOVERY series of general knowledge books for young school-aged children. The DISCOVERY series provides children with a wealth of information on the world around them, as well as answering many of their questions. What, for instance, makes a train go along? What lives in the depths of rivers and seas? Is there life on the other planets? What is a boy or girl made of? This book provides the answer to the latter question: a boy or girl is not made of 'sugar and spice and all things nice', but of cells. Reading it a child will learn all there is to know about cells: what they look like, what they are made of, what colour they are.

DISCOVERY

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